**Plasmodium Species among the Inhabitants of Iwo Community, Southwestern Nigeria**

Christopher Igbeneghu and Alexandra B. Odaibo

1Department of Biomedical Sciences, Faculty of Basic Medical Sciences, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria

2Department of Zoology, Parasitology Unit, University of Ibadan, Ibadan, Oyo State, Nigeria

**Abstract:** In malaria endemic area, co-infection of more than *Plasmodium* spp. in malaria subjects is thought to be common but there is dearth of information on their interactions. The present study was to determine the outcome of *Plasmodium* spp. interactions among malarial subjects in Iwo community, Southwestern Nigeria. Seven hundred thirty-three malaria subjects (362 men and 371 women) ≥16 years of age were recruited for this study. Thick and thin Giemsa-stained blood smears were prepared for malarial parasite identification and quantification. Estimations of haematocrit, haemoglobin concentration and platelet and leukocyte counts were made using an automated Coulter counter (STKS model). A p-value < 0.05 was considered significant. Out of the 733 malarial subjects examined, 684 (93.3%) had *P. falciparum* only, 22 (3.0%) had *P. malariae* only and 27 (3.7%) had both *P. falciparum* and *P. malariae*. The mean values of haematocrit, leucocyte, platelet and haemoglobin concentration for subjects with mixed *Plasmodium* spp. were significantly lower than those for subjects with *P. falciparum* only or *P. malariae* only. Mean parasite density of mixed *Plasmodium* spp. infection was significantly higher than that of *P. falciparum* only or *P. malariae*. Mixed *Plasmodium* spp. exhibited positive interactions resulting in aggravated effect.

**Key words:** Malarial Parasites • Co-Infection • Interactions • Haematological Parameters

**INTRODUCTION**

In endemic area, co-occurrence of more than one *Plasmodium* species in an individual is common [1, 2]. However, there has been only sporadic interest in this subject as pointed out by some authors [3-5]. According to Raso *et al.* [6] this is explained on some grounds. First, most field workers and research groups have focused on single parasite-single host interactions and secondly, interactions between different parasite species are complex, hence challenging to elucidate [7]. Also, most previous studies have focused on a narrow age range (for example school-age children) and adults have not been given attention [8, 9].

Available reports on the impact of multiple infections by *Plasmodium* species are conflicting. For instance, there is no compromise about whether mixed *Plasmodium* species interactions ameliorate clinical malaria or aggravate it [10-13]. In Nigeria, malaria is quite endemic and studies have shown that all four *Plasmodium* species exist among the human population [14-16]. However, studies on *Plasmodium* species are few [14, 15] and none of these studies examined the outcome of *Plasmodium* species interactions.

**MATERIALS AND METHODS**

**Study Area and Subjects:** The study was carried out in Iwo, a semi-urban community in Southwestern Nigeria. It is situated between Latitudes 7°37´30˝ and 7°38´30˝N and Longitudes 4°10´30˝ and 4°12´00˝S.

A total of 733 malarial subjects (371 women and 362 men) were screened for this study after clinical examination and informed consent was obtained. Ethical approval for this study was obtained from the Joint Ethical Committee of Ladoke Akintola University Teaching Hospital, Osogbo and Ladoke Akintola University of Technology, Ogbomoso, Nigeria. A sample of 5 mL of venous blood was collected from each participant into ethylenediaminetetraacetic acid (EDTA)
bottles for laboratory investigations. Thick and thin blood films stained with 3% Giemsa were examined for estimation and identification of malaria parasites. At least 200 microscopic fields were examined before declaring a smear as negative. The number of parasites present in each thick film in 200 leukocyte counts was determined (if less than 10 parasites were counted, counting was continued to 500 leukocytes). For the positive slides, the number of parasites counted per 200 or 500 leukocytes was used to calculate parasite density on the basis of the individual’s true leukocyte count per microliter of blood. Estimations of haematocrit, haemoglobin concentration and platelet and leukocyte counts were made using an automated Coulter counter (STKS model).

**Statistical Analysis:** Differences between percentages and proportions were examined using a Chi-square test. Sample means were compared by Student’s t test. A p value < 0.05 was considered statistically significant.

**RESULTS**

Table 1 shows the distributions of *Plasmodium* spp. in relation to sex and age. Of the 733 malarial subjects examined, 684 (93.7%; 371 females and 362 males) had *P. falciparum*, 22 (3.0%; 13 females and 9 males) had *P. malariae* and 27 (3.7%; 12 females and 15 males) had both *P. falciparum* and *P. malariae*. There was no significant difference in the distribution of single and mixed *Plasmodium* spp. between females and males ($\chi^2 = 1.08$, df = 2, p = 0.2). Also, there was no significant difference in the distribution of single and mixed *Plasmodium* spp. with respect to age ($\chi^2 = 6.99$, df = 3, p = 0.1).

Table 2 compared the mean haematological values and parasite densities of subjects infected with single and mixed *Plasmodium* spp. The mean values of haematocrit, total leucocyte count, platelet count and haemoglobin concentration of *P. falciparum* were not significantly

**Table 1: Distribution of *Plasmodium* species by Sex and Age among the Study Population in Iwo, Nigeria**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sex</th>
<th>No. Examined</th>
<th>P. f (%)</th>
<th>P. m (%)</th>
<th>P. f+P. m (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td>P. f</td>
<td>P. m</td>
<td>P. f+P. m</td>
</tr>
<tr>
<td>Female</td>
<td>371 (50.6)</td>
<td>346 (47.2)</td>
<td>13 (1.8)</td>
<td>12 (1.6)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>362 (49.4)</td>
<td>338 (46.1)</td>
<td>9 (1.2)</td>
<td>15 (2.1)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>733 (100.0)</td>
<td>684 (93.3)</td>
<td>22 (3.0)</td>
<td>27 (3.7)</td>
<td></td>
</tr>
</tbody>
</table>

**P. f**: *Plasmodium falciparum*

**P. m**: *Plasmodium malariae*

**P. f+P. m**: mixed *Plasmodium falciparum* and *P. malariae*

**Table 2: Haematological Values and Parasite Densities of *Plasmodium* species Infected Subjects in Iwo, Nigeria**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>P. f</th>
<th>P. m</th>
<th>P. f+P. m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haematocrit (%)</td>
<td>Mean±S.D</td>
<td>Mean±S.D</td>
<td>Mean±S.D</td>
</tr>
<tr>
<td>n=684</td>
<td>34.6±5.1</td>
<td>34.5±5.1</td>
<td>31.4±5.7</td>
</tr>
<tr>
<td>Total Leucocyte Count</td>
<td>3.9±1.5</td>
<td>4.0±1.5</td>
<td>3.0±0.7</td>
</tr>
<tr>
<td>(10^9/L)</td>
<td>135.7±34.5</td>
<td>136.8±19.1</td>
<td>124.6±15.2</td>
</tr>
<tr>
<td>Platelet Count (10^9/L)</td>
<td>12.0±1.7</td>
<td>12.4±1.2</td>
<td>11.0±2.0</td>
</tr>
<tr>
<td>Haemoglobin Concentration</td>
<td>2.7±4.3</td>
<td>0.7±0.6</td>
<td>4.0±3.2</td>
</tr>
</tbody>
</table>

**P.f**: *Plasmodium falciparum*; **P.m**: *P. malariae*; **P.f+ P.m**: mixed *P. falciparum* and *P. malariae*
The distribution of species of \textit{Plasmodium} is not found among indigenous Nigerians \cite{18}. Infections might be a higher overall parasite load.

Erhabor reported in a study carried out in the South-South \cite{21} who opined that the mechanism for the higher parasitaemia indicate greater malaria severity than the distribution of \textit{Plasmodium} spp. infection had shown that mixed falciparum-malariae species infection most likely aggravate the outcome of malaria rather than alleviate it. If lower haematological values and higher parasitaemia indicate greater malaria severity then this result conflicts with those that reported lower frequencies of severe malaria in dual \textit{P. falciparum} and \textit{P. vivax} infections \cite{11, 12}. However, the result is in line with that of Genton \textit{et al.} \cite{21} who found that patients with mixed infections of \textit{P. falciparum} and \textit{P. vivax} were more likely to present with severe malaria than those infected with a single \textit{Plasmodium} sp. The findings of Gopinathan and Subramanian \cite{22}, Lyn \cite{23} and Tjitra \textit{et al.} \cite{24} were in line with those of Genton \textit{et al.} \cite{21} who opined that the mechanism for the higher proportion of severe malaria among patients with mixed infections might be a higher overall parasite load.

There was a 93.6\% and 6.4\% prevalence of \textit{P. falciparum} and \textit{P. malariae} respectively of the malarial parasites seen in this study. Ademowo \textit{et al.} \cite{17} reported 92.6\% and 7.4\% prevalence of \textit{P. falciparum} and \textit{P. malariae} respectively in a rural community in Southwestern Nigeria. Madaki and Zoakah \cite{20} in Jos, Northern Nigeria, reported that \textit{P. falciparum} and \textit{P. malariae} respectively accounted for 96.6\% and 3.4\% of the malarial parasites seen while May \textit{et al.} \cite{15} in Ibadan, reported 78.7\% were \textit{P. falciparum}, 13.5\% were \textit{P. malariae} while 7.8\% were \textit{P. ovale}. Several studies have shown that \textit{P. falciparum} is the most prevalent species in Nigeria accounting for most of malaria cases with \textit{P. malariae} following \cite{18}.

The distribution of the species of \textit{Plasmodium} in the present study did not depend on sex or age. This means that an adult in this malaria endemic area can harbor either or both \textit{Plasmodium} spp. irrespective of the sex or age. This result is in line with the studies of Mehlotra \textit{et al.} \cite{1, 2} which reported random distribution of mixed \textit{Plasmodium} spp.

Subjects with mixed \textit{Plasmodium} spp. infection had significantly higher mean parasite density but lower mean haematological values than those with either \textit{P. falciparum} or \textit{P. malariae}. These observations probably suggest that mixed falciparum-malariae species infection most likely aggravate the outcome of malaria rather than alleviate it. If lower haematological values and higher parasitaemia indicate greater malaria severity then this result conflicts with those that reported lower frequencies of severe malaria in dual \textit{P. falciparum} and \textit{P. vivax} infections \cite{11, 12}. However, the result is in line with that of Genton \textit{et al.} \cite{21} who found that patients with mixed infections of \textit{P. falciparum} and \textit{P. vivax} were more likely to present with severe malaria than those infected with a single \textit{Plasmodium} sp. The findings of Gopinathan and Subramanian \cite{22}, Lyn \cite{23} and Tjitra \textit{et al.} \cite{24} were in line with those of Genton \textit{et al.} \cite{21} who opined that the mechanism for the higher proportion of severe malaria among patients with mixed infections might be a higher overall parasite load.

\section*{DISCUSSION}

This study showed that \textit{P. falciparum} and \textit{P. malariae} were the only species of \textit{Plasmodium} associated with the study population. Molineaux \textit{et al.} \cite{14} and May \textit{et al.} \cite{15} reported \textit{P. falciparum}, \textit{P. malariae} and \textit{P. ovale} in Garki, Northern Nigeria and Ibadan, Southwestern Nigeria respectively. Also, Ademowo \textit{et al.} \cite{17} reported \textit{P. falciparum} and \textit{P. malariae} in a rural community in Southwest Nigeria and \textit{P. falciparum} and \textit{P. vivax} were reported in a study carried out in the South-South by Erhabor \textit{et al.} \cite{16} although reports had shown that \textit{P. vivax} is not found among indigenous Nigerians \cite{18}. The distribution of species of \textit{Plasmodium} has been reported to vary greatly across the country. This distribution of \textit{Plasmodium} species is influenced by factors of parasite, vector and human \cite{14}. It is known that slightly distinct environmental characteristics affect transmission patterns and may have an effect in the way different human malaria species establish in the human population \cite{19}.

In addition, the mean parasite density for mixed \textit{P. falciparum} and \textit{P. malariae} infected subjects was significantly higher than that of subjects with \textit{P. falciparum} only (p < 0.001) or \textit{P. malariae} (p < 0.001) only.

\section*{CONCLUSION}

\textit{Plasmodium falciparum} and \textit{P. malariae} were the only \textit{Plasmodium} spp. detected among the study population and \textit{P. falciparum} was more prevalent. Mixed \textit{P. falciparum} and \textit{P. malariae} infections exhibited positive interactions resulting in aggravated effect.
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REFERENCES


